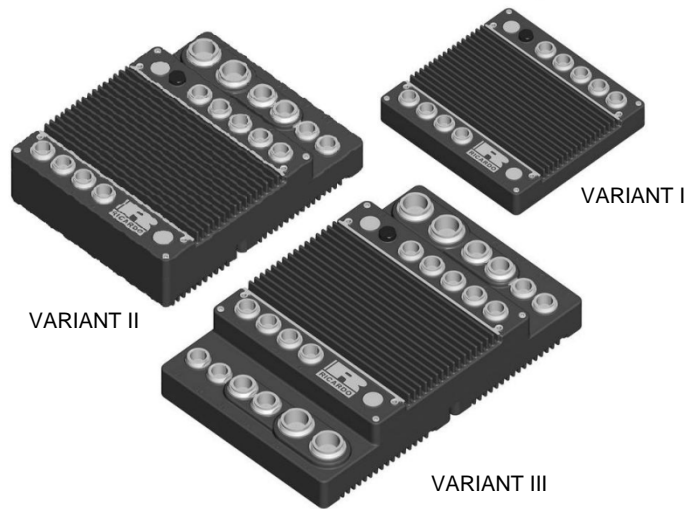


## OVERVIEW

The rCube2 embedded processing unit is a modular rapid prototyping system intended for control strategy development in an automotive environment. Applications are developed in MATLAB® / Simulink® environment and integrated into the AUTOSAR (AUTomotive Open System ARchitecture) compliant base software. Ricardo provides the base software and all necessary device drivers.



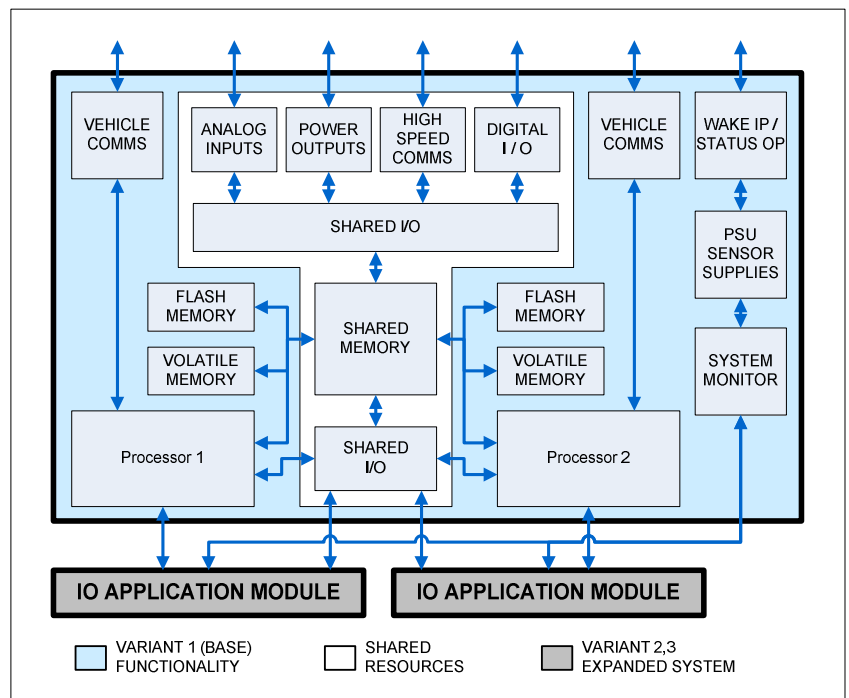
## KEY FEATURES

rCube2 features a powerful base Input/Output function with additional application I/O modules available to suit the target application. rCube2 is packaged in a cast aluminium enclosure and sealed for use in the most demanding automotive environments.

- Dual application processor platform
- Modular expandable I/O system
- Real-time control with parallel computing core
- Robust packaging designed for in-vehicle use
- Dual voltage 12/24 V systems
- Advanced system monitoring and protection

## BASE SYSTEM

The rCube2 base system (Variant I in the picture above) contains the applications processors, communications interfaces (Ethernet, CAN, FlexRay, LIN & RS232). In addition to this a range of general purpose input output functionality is supported. The system is protected by an Advanced Monitoring Unit (AMU) which provides thermal and under/over voltage protection. The AMU also manages application wake-up and shutdown. CAN based, time based and periodic wake-up events are supported.



## BASE EMBEDDED PROCESSING UNIT I/O SUMMARY

The following table summarises the input, output and communications capability of the rCube2 base unit:

Processor 1		Processor 2		Shared resources	
CAN	4	CAN	4	Analog inputs (general)	18
FlexRay	2	FlexRay	2	Analog inputs (thermistor)	8
Ethernet	1	Ethernet	1	Digital inputs (8 can be set to outputs)	16
rCube2 interlink	2	rCube2 interlink	2	Low side power outputs (2 A)	4
LIN	1	LIN	1	Relay power outputs ( $\leq 250$ mA)	8
RS232	1	RS232	1		

## CORE PROCESSING SYSTEM

The applications core is based on two Infineon TC1797 processors. The processors are arranged in a symmetrical configuration and as such, applications can run on either one of the processors or split across both processors.

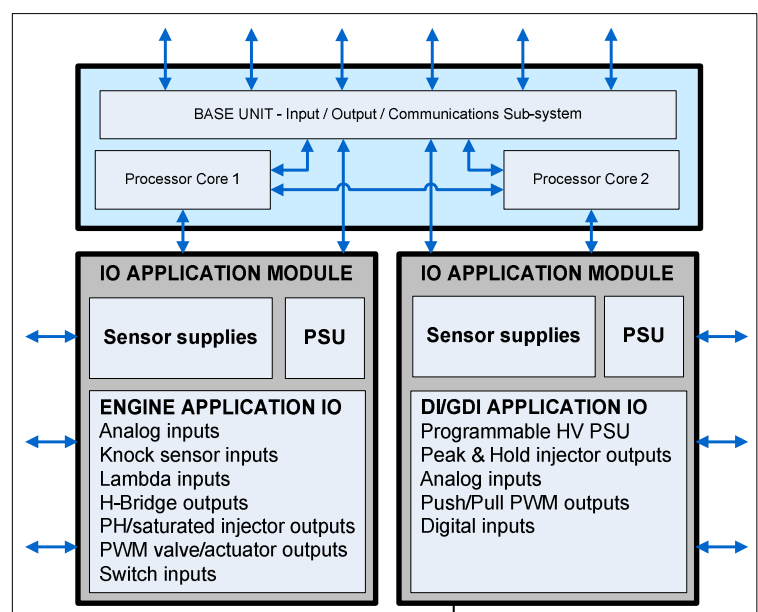
	Performance	Memory (per processor)	
		Volatile	Non-volatile
Processors (internal)	150 MHz clock	192 kB	4 MB
External (on-board)	75 MHz bus	4 MB	4 MB

The rCube2 embedded processing unit incorporates facility to install an ETAS interface board for each of the application processors and retain the system's environmental integrity through installation of connectors on the top side of the enclosure. This optional unit allows advanced access to the micro-controller resources for calibration and run-time monitoring if desired by the user.

## SYSTEM MODULARITY

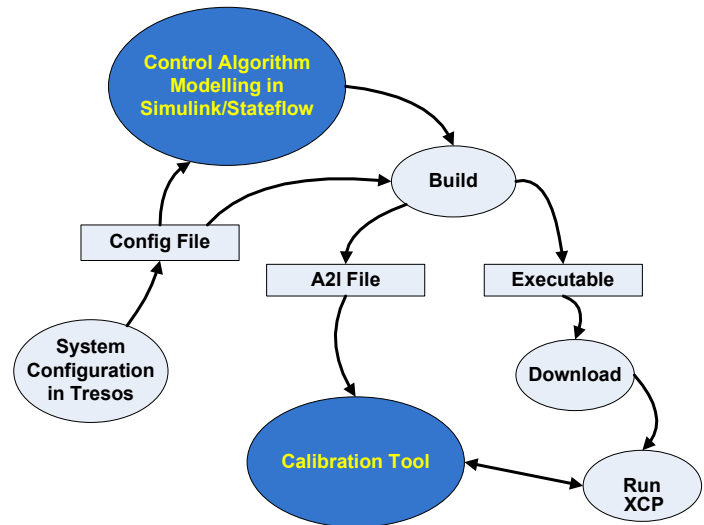
The base unit is expandable with one or two application specific input/output modules (featured in separate datasheets). Ricardo supplies input/output application modules to cover a range of system applications.

- 6 cylinder gasoline and ethanol injected engines
- 8 cylinder GDI and DI systems
- AMT and AT transmission systems
- 30 kW 3-phase inverter module (planned)
- Custom developed modules



## DEVELOPMENT ENVIRONMENT & TOOLS

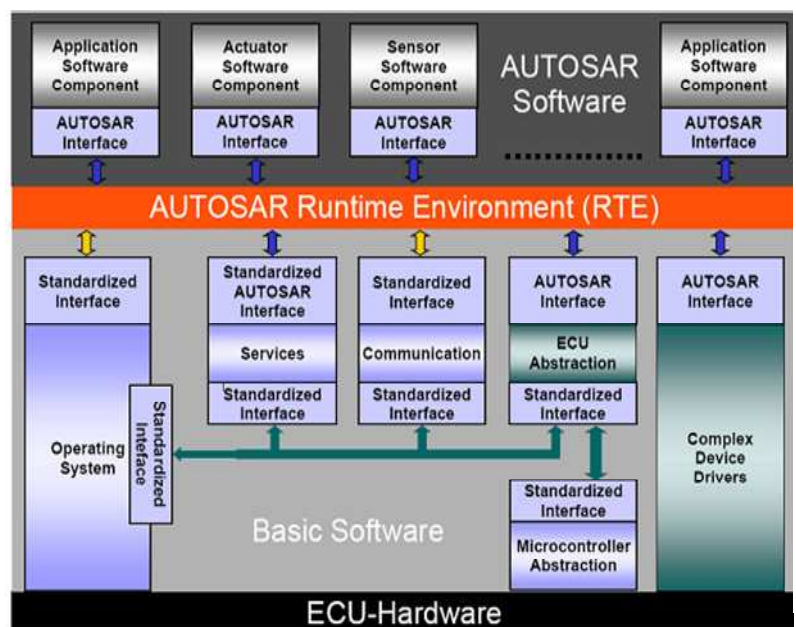
The validated system is based on use of the Tasking Compiler for compilation and build of the downloadable files for each processor. User applications are developed as software components using MATLAB/Simulink with Real-Time Workshop® Embedded Coder. Ricardo supplied tools manage the build process generating the download files and the ASAP2 file for calibration tools. PCAN USB to CAN interface (not supplied) from Peak Systems GmbH is required for data download to the system.



## EMBEDDED OPERATING SYSTEM

rCube2 uses a real-time embedded operating system with micro-controller abstraction layer components supplemented by complex device drivers to support custom functionality such a high speed communications and engine control. The platform is AUTOSAR compliant making all interaction between the platform software and the application software via the RunTime Environment (RTE) component. This allows the user to develop portable software readily transferable to a production system.

The user has access to an operating system configuration utility to perform the necessary low-level application configuration. Ricardo can develop pre-configured systems to suit user applications leaving the user to concentrate on the application level development.



## ELECTRICAL INTERFACE / INPUT-OUTPUT SET

Power supply specifications		
Supply voltage	6.0 V to 40 V	Compliant with 24 V systems to ISO7637 part 2
Reverse battery protection	built in	
Shutdown current	< 2 mA	System inactive
Standby current	< 5 mA	Periodic wake-up events programmed
Operating current	< 500 mA	Peripheral I/O inactive, application processors active

The rCube2 embedded processor unit without additional modules supports the following signal interfaces:

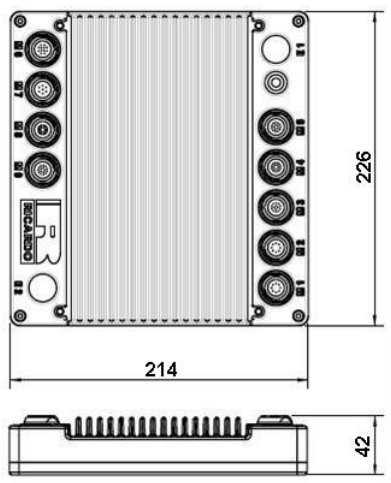
Low power signal specifications		
Analogue inputs	18	14-bit resolution, ~15 kHz bandwidth, 100 kHz sampling rate, 0-5 V input range, 25 kΩ input impedance, short circuit protected
Analogue inputs NTC thermistors	8	12-bit resolution, slow scanning (~1 Hz), short circuit protected, programmable pull-up resistance (4.7 kΩ/334.7 kΩ)
Sensor supply	2	Independent 5 V, 250 mA each, short circuit protected
Digital inputs/outputs	8 OR 8	Input: Configurable* pull-up/down (18 kΩ/ > 100 kΩ in groups of 4), interrupt capable, short circuit protected, switching threshold: $V_{LOW\_MAX} = 2.57\text{ V}$ , $V_{HIGH\_MIN} = 3.37\text{ V}$ Output: Battery level, 200 mA current limited with configurable HS/LS/push-pull drive in groups of 4, with freewheeling diodes & short circuit protection
Digital inputs	8	Configurable* pull-up/down (18 kΩ/ > 100 kΩ in groups of 4), interrupt capable, short circuit protected, switching threshold: $V_{LOW\_MAX} = 2.57\text{ V}$ , $V_{HIGH\_MIN} = 3.37\text{ V}$ ; hardware assisted detection of duty cycle of PWM and frequency

Power output specifications		
Low side drive outputs	4	2 A per channel, PWM capable, over-current and short circuit protection, common external pin freewheel diodes, internal diagnostics and feedback
Relay drive outputs	4	250 mA low side drives, diagnostics feedback & short circuit protected, relay 1 driven by processor 1, relay 2 driven by processor 2, relay 3 driven by processors 1 AND 2, relay 4 driven by processor 1 OR 2
Diagnostic LED outputs	4	Power supply, system monitor, processor 1 and processor 2 indication, high-side current-limited 20 mA output drive with short circuit protection.

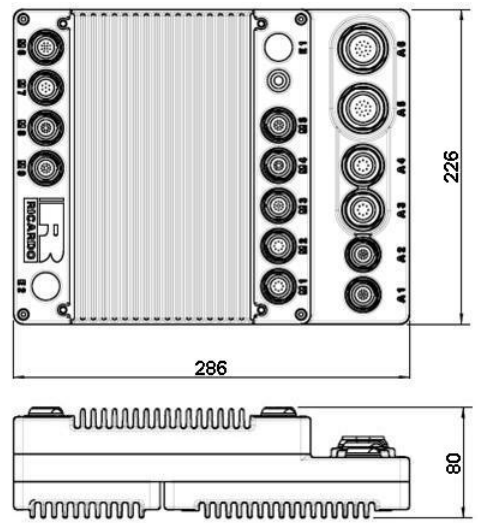
Serial communications		
CAN interface	8	4 dedicated to each application processor core – 2/4 with integrated termination network, CAN 2.0B, capable of generating system wake-up
FlexRay Interface	4	2 dedicated to each application processor core – all with integrated termination network, capable of generating system wake-up
LIN interface	2	1 dedicated to each application processor core,
RS232 driver	2	1 dedicated to each application processor core, full-duplex
Ethernet 100Base-TX	2	1 dedicated to each application processor core (TCP/IP)
rCube2 interlink	4	2 dedicated to each application processor core (100 Mbit/s data exchange link to interconnect multiple rCube2 systems together)

\*Note: Pull-up/pull-down configurability is an optional feature available in specific models

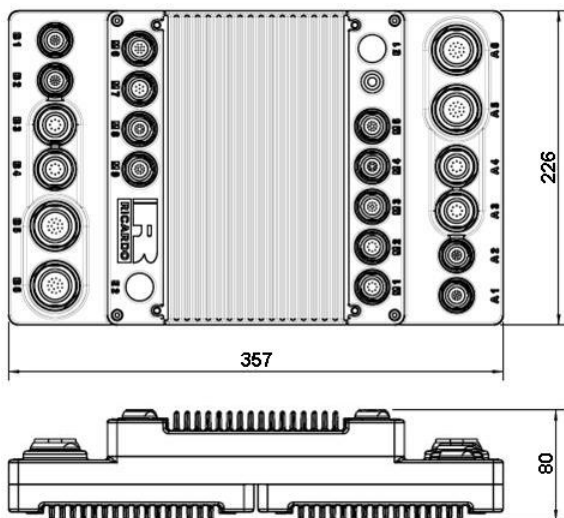
## MECHANICAL DIMENSIONS



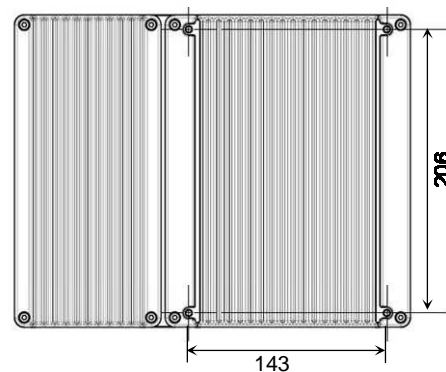
VARIANT I



VARIANT II



VARIANT III



Mounting hole locations  
VARIANT II/III base casting

All dimensions are in [mm]

## MOUNTING SPECIFICATION

Product mounting is by four threaded holes on the top surface of the VARIANT I enclosure and via holes on the VARIANT II and VARIANT III base castings. The footprint of the mounting holes is identical between the VARIANT I unit and the heat sink casting for the I/O application modules of VARIANT II and VARIANT III.

## SYSTEM MONITORING AND POWER CONTROL

An integral system monitor is responsible for waking-up the unit and managing system shutdown, it supports both CAN/FlexRay wake-up events and periodic wake-up events. The system monitor supports multiple channels of internal thermistor measurement, with configurable overheat alarm warnings issued to the application processors and hard-limit enforced system shutdown.

### Monitor pendant

For development purposes Ricardo supply an LED pendant containing four indicators to identify the status of the system. Their indication is identified as follows:

1. System power integrity
2. System monitor status (signifies normal operation, overheat status)
3. Processor 1 application status (user programmable)
4. Processor 2 application status (user programmable)

## ENVIRONMENTAL SPECIFICATIONS

Environmental parameter	Specification
Operating temperature	-40°C ~ +105°C (can be limited by custom I/O module s)
Storage temperature limits	-40°C ~ +125°C
Electrical transients	ISO7637 parts 1&2: 2002
Electro-magnetic compliance	CISPR22:1997 / FCC part 15
Electro-static discharge	IEC 61000-4-2
Water Ingress (with mating connectors installed)	IP68

## TOOLS AND SOFTWARE ENVIRONMENT SPECIFICATIONS

Item	Ricardo supplied	Specification
Operating system	✓	Elektrobit AutoCore™ 2008a
Processor peripheral drivers	✓	Infineon MCAL drivers
Application specific drivers	✓	Ricardo developed
Compiler	✗	Tasking version 3.3
System configuration	✓	Elektrobit Tresos Studio™ 'rCube2 Lite' edition
Calibration tools – XCP compliant	✗	INCA 6.x
Calibration hardware	✗	ETAS ETK S4.2a (CAN) OR Ethernet
MATLAB®/Simulink®/ Real-Time Workshop® Embedded Coder	✗ ✗ ✗	2008b onwards (2010b, 2011b)

## INPUT/OUTPUT APPLICATION MODULES

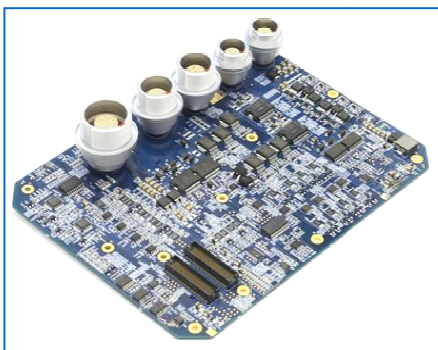
---

Ricardo supplies Input/Output application modules to cover a range of system applications.

- 6 cylinder gasoline and ethanol injected engines
- 8 cylinder GDI and DI systems
- AMT and AT transmission systems
- 30 kW 3-phase inverter module (planned)

Custom I/O modules can be developed to suit customer specific applications:

- 3-phase brushless DC motor drives
- data logging & telematics applications



**Powertrain module**



**GDI/DI module**

Full datasheets of the Input/Output application modules are available at [www.ricardo.com](http://www.ricardo.com)

### CONNECTOR INFORMATION

---

The rCube2 connector system is based on the rugged sealed Lemo™ 'K' series parts. One set of harness connectors as listed below are supplied with each rCube2 system. See rCube2 connector information datasheet for further specifications and suitable cables.

Connector function	Lemo order code*
Main power	FGG.2K.307.CYCK75
Power relay outputs	FGG.2K.312.CYCC75
DI/O	FGA.2K.318.CYCC75
Processor 1 comms	FGG.2K.316.CYCC75
Processor 2 comms	FGG.2K.316.CYCC75
PC host interfacing	FGC.2K.316.CYCC75
Inter-module comms	FGC.2K.316.CYCC75
Analog IP II inter-module comms	FGG.2K.314.CYCC75
Analog IP I and supplies	FGA.2K.318.CYCC75

\* Note the suffix (CYCxxx) determines the collet size for the cable and is dependant upon user application.

Full details of connectors and tooling are provided in the hardware user manual. These tools are not supplied by Ricardo.

### CONTACT RICARDO

---

Ricardo UK Limited  
Bridge Works  
Shoreham-By-Sea  
BN43 5FB  
England

Ricardo Inc.  
40000 Ricardo Drive  
Van Buren TWP  
MI 48111  
USA

Email: [rcube2-sales@ricardo.com](mailto:rcube2-sales@ricardo.com)